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EFFECT OF STORAGE TEMPERATURES, INJURY AND EXPOSURE ON WEIGHT LOSS AND SURFACE DISCOLORATION OF NEW POTATOES[1]

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INTRODUCTION

Refrigeration is regularly used to delay the development of decay, reduce loss in weight, and preserve the fresh appearance of new potatoes in transit and storage. When some transit refrigeration services are used the temperature of the potatoes may be reduced to 40°F. or slightly below in the colder parts of the load. Under commercial handling such potatoes may be shifted from the low temperatures of transit and storage to rather high temperatures often prevailing in market channels. Though the tubers may appear uninjured when removed from the low temperatures, injuries may become pronounced at the higher temperatures.

Experiments were undertaken, therefore, to determine, by holding tests under controlled conditions, the effects of low storage temperatures on the

[1] The author appreciates the advice of E. J. Koch in the statistical analysis.
[2] Associate Pathologist.

appearance of uninjured and injured tubers after they were moved to a higher temperature.

Materials and Methods

Two experiments were conducted with Irish Cobbler potatoes dug when the vines were about three-fourths dead and picked up and taken from the field immediately.

In the first experiment potatoes were dug, skinned and bruised, and exposed in the field at Elizabeth City, North Carolina. A portion of each lot of potatoes was kept uninjured, and corresponding portions were skinned and bruised and then placed in burlap sacks in a packing shed or exposed to the sun and wind from 2 to 4 hours. Tubers with the skin nearly or completely intact were used for the uninjured class. To obtain severe feathering (skinning) the tubers were placed in burlap sacks and shaken, a procedure which in many cases removed as much as 90 per cent of the skin. Part of these skinned potatoes were hit with a metal file to inflict an additional injury resembling a deep shatter bruise. The tubers to be exposed were divided into 40-pound lots and placed in burlap sacks in the middle of a freshly plowed field. During exposure the sacks of potatoes were far enough apart to allow free air movement and an equal opportunity for possible wind damage and heat absorption. The tubers for the unexposed lots were held in a packing shed during this period. The air temperature during exposure averaged 76.5°F., with a maximum of 78° and a minimum of 76°. The day was slightly cloudy. There was a light breeze, and the relative humidity averaged 55.6 per cent during the period of exposure. After exposure the tubers were hauled in a closed panel truck to Beltsville, Maryland. The contents of the burlap sacks of each treatment were then thoroughly mixed and three 10-pound lots from the mixture were put in paper sacks and stored. About 36 hours elapsed after digging before these tubers were placed in storage.

During the first week after treatment, called herein the initial storage period, the 10-pound lots of each of the treatments were held at 40°, 50°, and 70°F. All of the lots were then moved into the same 70° room and held for an additional week. At the ends of the first and second weeks all the potatoes and those browned or decayed were weighed.

Tubers for the second experiment were obtained from Accomac, Virginia, and were hauled immediately to Beltsville and stored at 70°F. Because weather conditions were not suitable for conducting the experiment seven days elapsed before the potatoes were injured and exposed in the same manner as in the previous experiment. The air temperature during the exposure period averaged approximately the same as in the preceding experiment and the maximum for the exposure period was the same, 78°.

No records were obtained on relative humidity or air movements. After treatment the tubers were placed in paper sacks and stored during the initial storage period at the same temperature (40°, 50°, and 70°) as in the first experiment, and later were moved to the 70° room for the second week. At the ends of the first and second weeks all the potatoes and those browned or decayed were weighed as in the first experiment.

Throughout the two experiments the temperatures of the storage rooms remained relatively constant. An attempt was made to keep the relative humidity of all the storage rooms at 85 per cent. This was accomplished with only a moderate amount of variation except in experiment 2 in the 50° room, where the humidity dropped to approximately 50 per cent.

Results

Total Weight Loss During Two Weeks' Storage

The effect of the initial storage temperature on the total loss of weight of the injured potatoes, determined as percentage of the original weight, was too erratic for definite conclusions to be drawn. The weight loss of the uninjured potatoes, however, was consistently less when they were stored the first week at 40°F. than when stored the entire two weeks at 70°. Injured potatoes in all cases lost more weight than the uninjured and this difference was highly significant regardless of initial storage temperature. The effect of exposure was not significant.

Weight Loss During Final Week at 70° F.

In both experiments it was found that the temperature of the initial storage period had a highly significant effect on the weight lost by new potatoes during the final week at 70°F., as shown in table 1. In experiment 1 potatoes stored constantly at 70° lost significantly less weight during this period than tubers stored initially at the two lower temperatures. Also those stored initially at 50° lost less weight than those stored at 40°. In the second experiment there was no significant difference in weight loss of potatoes that had been stored initially at 70° and 50°, the weight loss at both temperatures being somewhat erratic; but potatoes from both of these temperatures lost considerably less weight than the potatoes stored initially at 40°. It is also shown in this table that injury significantly increased the weight loss during this storage period and was more important in determining the weight loss than previous storage temperature.

Surface Browning and Decay after Two Weeks' Storage

The influence of the initial storage temperature on the development of surface browning of new potatoes is shown in table 2. In the majority of cases, less browning developed on potatoes stored constantly at 70°F. than on those stored at lower temperatures during the first week. The difference in the browning on potatoes stored constantly at 70° and those

stored initially at 40° was especially significant, whereas browning on those from the 50° storage room was intermediate. Both injury and exposure had a decided influence on the development of surface browning, but the effect of injury was greater than that of exposure.

Additional data on browning, not presented in the table, were taken. These data were concerned with the intensity of the color and rapidity of development of the browned areas on tubers with different initial storage temperatures. The discolored areas were considerably darker and often became sticky on tubers that had been stored at 40°F. The individual tubers stored constantly at 70° showed the least intense surface discolora-

TABLE 1.—*Effect of length of exposure, type of injury and initial storage temperature on weight loss of new potatoes during subsequent storage at 70° F.*

Experiment No. and Initial Storage Temperature °F.	Type of Injury	Weight Loss				
		Treatment Mean after Indicated Exposure			Injury Mean	Temperature Mean
		None	2 Hours	4 Hours		
		Per cent	Per cent	Per cent	Per cent	Per cent
Experiment 1:						
40		1.58	1.12	1.28		
50	Uninjured	1.33	1.07	1.14	1.14	
70		0.99	0.82	0.95		
40		2.36	2.25	2.11		1.93
50	Feathered	2.05	1.64	1.75	1.83	1.67
70		1.54	1.41	1.39		1.30
40	Feathered	2.24	2.18	2.27		
50	and	2.15	1.83	2.09	1.94	
70	bruised	1.67	1.43	1.57		
Exposure Mean (Per cent)		1.77	1.53	1.67		
Experiment 2:						
40		0.52	0.53	0.60		
50	Uninjured	0.43	0.42	0.50	0.46	
70		0.38	0.37	0.40		
40		1.49	1.71	1.68		1.26
50	Feathered	1.35	1.48	1.34	1.45	1.05
70		1.22	1.40	1.36		1.04
40	Feathered	1.56	1.59	1.65		
50	and	1.20	1.27	1.44	1.43	
70	bruised	1.29	1.38	1.53		
Exposure Mean (Per cent)		1.05	1.13	1.17		

L.S.D. for Experiment 1:
Treatment means—
5 per cent 0.170
1 per cent 0.227
Temperature, exposure, or injury means—
5 per cent 0.098
1 per cent 0.131

L.S.D. for Experiment 2:
Treatment means—
5 per cent 0.201
1 per cent 0.268
Temperature, exposure, or injury means—
5 per cent 0.116
1 per cent 0.155

tion, and the discoloration of those from 50° storage was intermediate. The rate of development of the browned areas on the tubers during the final week of storage also showed considerable variation. At the end of the first week of storage potatoes stored at 70° showed the most browning and those stored at 40° showed the least. At the end of the second week, however, the relative amounts of browning were completely reversed; tubers stored the first week at 40° showed the most browning and those stored the entire time at 70° showed the least.

No decay caused by bacterial soft rot or other organisms was noted in either of the experiments.

TABLE 2.—*Effect of length of exposure, type of injury, and initial storage temperature on percentage of the final weight of new potatoes showing surface browning.*

Experiment No. and Initial Storage Temperature ° F.	Type of Injury	Surface Browning: Treatment Mean after Indicated Exposure: None	2 Hours	4 Hours	Injury Mean	Temperature Mean
		Per cent	Per cent	Per cent	Per cent	Per cent
Experiment 1						
40	Uninjured	44.8	60.7	37.7		
50	Uninjured	19.0	20.9	28.0	30.0	
70	Uninjured	13.9	15.3	29.9		
40	Feathered	62.6	77.3	73.4		66.9
50	Feathered	48.0	56.0	59.8	52.6	42.5
70	Feathered	19.6	33.3	43.3		31.5
40	Feathered and bruised	78.1	85.2	82.4		
50	Feathered and bruised	33.6	51.4	65.9	58.3	
70	Feathered and bruised	30.9	47.0	50.2		
Exposure Mean (Per cent)		38.9	49.7	52.3		
Experiment 2						
40	Uninjured	20.0	22.1	36.3		
50	Uninjured	6.1	10.3	22.7	15.7	
70	Uninjured	4.3	6.6	13.0		
40	Feathered	86.6	86.9	88.2		67.8
50	Feathered	60.3	82.8	77.5	72.0	56.0
70	Feathered	39.7	62.3	63.5		34.5
40	Feathered and bruised	88.3	93.3	88.4		
50	Feathered and bruised	80.7	81.3	82.4	70.6	
70	Feathered and bruised	29.2	26.8	65.1		
Exposure Mean (Per cent)		46.1	52.5	59.7		

L.S.D. for Experiment 1
Treatment means—
5 per cent 11.1
1 per cent 14.9
Temperature, exposure or injury means—
5 per cent 6.4
1 per cent 8.6

L.S.D. for Experiment 2:
Treatment means—
5 per cent 11.3
1 per cent 15.1
Temperature, exposure or injury means—
5 per cent 7.3
1 per cent 9.7

Discussion

Smith (10) reported that both transpiration and respiration were factors in the loss of weight of potatoes in storage. Kimbrough (5), Appleman and Smith (2) and Appleman and Brown (1) presented evidence that there is an initial increase in rate of respiration when potatoes are shifted directly from a low to a higher temperature. In these studies there was a greater decrease in weight during the second week of potatoes that were shifted from 40° to 70°F. than in similar lots that remained constantly at 70°. It is apparent that avoidance of air temperature as low as 40° in transit and storage may be important in preventing weight loss of new potatoes.

Many workers have shown that surface browning may occur at skinned or other injured areas (4, 6, 7, 8, 9). In a report on handling and shipping tests with new potatoes Barger and others (4) stated that at 50° and 70°F. less browning developed at a high than at a low relative humidity. In the present studies it is shown that even with high humidity the browning increased significantly when the tubers were shifted from a low to a higher temperature. It is apparent, therefore, that with new potatoes the initial storage temperature as well as the relative humidity has an important effect on browning. Artschwager (3) showed that injured surfaces of potatoes do not form suberin or periderm as rapidly at temperatures of 40° and 50° as at 70°. The prevention of delay in the formation of these protective layers at the low temperatures used in these studies may explain in part the increased browning. It is also possible that other metabolic processes may be speeded as a result of a rapid change from a low to a higher temperature, and so an increased oxidation rate, as suggested by Rose and Fisher (8), may be responsible in part for the increased surface browning.

In these experiments an attempt was made to stimulate temperature conditions to which potatoes may be subjected during commercial handling. The data in these studies show that new potatoes stored at 40°F. lost more weight and browned more severely when transferred to higher temperatures than potatoes kept constantly at higher temperatures. The data also show that if temperature and humidity are favorable for the formation of protective layers at injured areas loss in weight and surface browning are decidedly reduced.

Summary

1. Potatoes stored constantly at 70° F. for 2 weeks showed less surface browning than those stored initially (first week after treatment) at 40° or 50° and then shifted to 70°.

2. Potatoes stored at 70°F. after an initial storage period at 50° showed less weight loss and less surface browning than those stored initially at 40°.
3. Tubers stored initially at 40°F. lost weight more rapidly after they were shifted to 70° than tubers stored constantly at 70°.
4. Initial storage at 40°F. was decidedly detrimental to the general appearance of new potatoes.

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EFFICACY OF CERTAIN FUNGICIDES AGAINST POTATO LATE BLIGHT AND ASSESSMENT OF LOSS DUE TO THE DISEASE

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INTRODUCTION

Late Blight of potatoes caused by *Phytophthora infestans* (Mont.) de Bary, takes a heavy toll of the crop almost every year in the Simla Hills which are one of the most important centers of potato production in

the country. The importance of the crop in these hills is particularly great since it serves as a source of seed supply to different parts of the country. No reliable figures regarding actual losses caused by disease are available, but it has been observed that in years of severe attacks by the disease that field after field planted to the potato crop is wiped out and no yield worth the name is produced from fields of this nature. The disease formerly was not considered to be of much importance in the plains of Northern India but since the introduction of cold storage facilities, when once the disease has appeared in a sporadic form, it is carried in the seed while in storage from one year to the other so that control of the disease requires very serious attention both in the hills and the plains. With this object in view some experiments to test the efficacy of different fungicides against Late Blight and assessment of loss caused by the disease were conducted at the Central Seed Potato Certification Station, at Kufri, situated 9 miles away from Simla at an altitude of about 9,000 feet, during 1948 and 1949. The results obtained are of vital interest to the potato growers and are therefore recorded here.

Experimental

Altogether 9 treatments including control were used in our test in plots 13'6" x 8', in quadruplicates, in randomized blocks. Each set of treatments consisting of a block was separated from the other set by 5 feet and each plot was 4 feet apart in order to avoid as far as possible, spray falling from one bed to the other.

As regards cultural operations and manuring, common practices that prevail in that tract were strictly followed and seed potatoes of *Darjeeling Red Round* variety were planted on ridges 2 ft. apart. Seed tubers of almost uniform size were used in these experiments.

The treatments included in these tests are given below:

No.	Treatment	Strength of Spray or Dust
1	Dithane	1½ pounds per 100 gallons
2	Dithane + zinc sulphate + lime	1½+1+½ pounds per 100 gallons
3	Dithane + zinc sulphate + lime + D.D.T.	1½+1+½ pounds per 100 gallons + ⅛th per cent D.D.T.
4	Perenox ¼ per cent	2½ pounds per 100 gallons
5	Perenox ½ per cent	5 pounds per 100 gallons
6	Burgundy Mixture	10:12½:50
7	Burgundy Mixture + D.D.T.	10:12½:50+⅛th per cent DDT
8	Perelan Dust	Ready-made dust available commercially
9	Untreated Control	

The spray in every case was applied at the rate of 100 gallons per acre whereas Perelan (Treatment 8) was dusted at 15 pounds per acre.

The first application of any of the treatments was given on the 10th of July 1948, and the appearance of Late Blight was observed during the third week of August 1948. The occurrence of the disease in Simla Hills during 1948 was delayed because of the late monsoons. In the following year the treatments were started on the 3rd of August 1949 in view of the delayed appearance of the disease during the previous year. The disease appeared at the end of the first week in August 1949, and in a more severe form than in 1948. The treatments were continued regularly at intervals of 10 days and a total of seven applications were made during a season. The spraying was done by means of a 4-oaks type pneumatic hand-sprayer whereas dusting was carried out by a hand-worked rotary duster.

Efficacy of Different Fungicides:—The efficacy of different fungicides against Late Blight was determined by its effect on yield. With this object, the yield of individual plants was recorded in different treatments at the harvesting time. The data are set out in table 1.

As the disease appeared in a more severe form during 1949 the effect of fungicides is more marked during that year. Figure 1 shows the yield obtained under different treatments, arranged in order of efficacy against Late Blight, as judged by the average yield of 2 years the experiments were conducted.

TABLE 1.—*Yield per 100 plants under different treatments*

Sl. No.	Treatments	Yield per 100 plants* 1948 Lbs.	Oz.	1949 Lbs.	Oz
1	Dithane	26	5.25	18	0.3
2	Dithane + zinc sulphate + lime	18	14.25	15	9.6
3	Dithane + zinc sulphate + lime + D.D.T.	22	3	23	10.4
4	Perenox ¼ per cent	33	—	28	9.5
5	Perenox ½ per cent	32	5	30	3.6
6	Burgundy Mixture	37	14	48	2.6
7	Burgundy Mixture + D.D.T.	27	9.5	46	0.9
8	Perelan Dust	29	4	28	8
9	Untreated Control	25	9	10	5.7

* As the entire potato crop, including the experimental plots at the Central Seed Potato Certification Station, Kufri, is maintained in Virus-free condition, which necessitates the roguing of diseased plants, the yield records on 100 plants basis were taken.

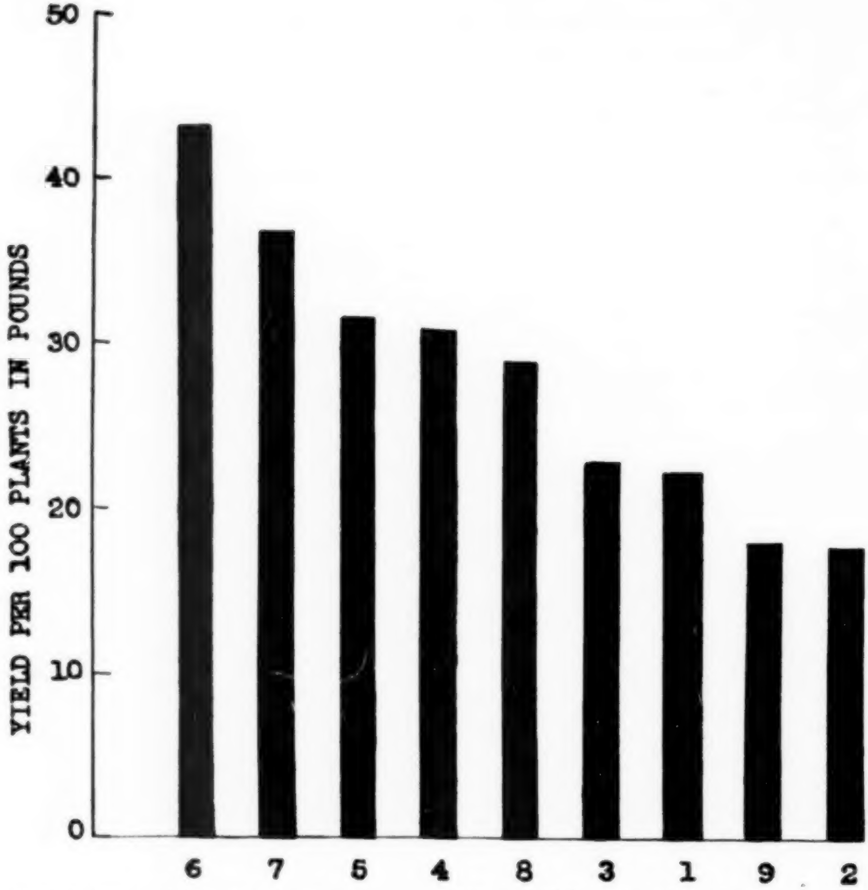

Figure 1:—Average yield for two seasons, 1948 and 1949, under different treatments arranged in order of efficacy on yield basis.

The data presented in table 1 show that the yield in plots sprayed by ¼ per cent Perenox and Burgundy Mixture is increased on the average by 71.4 and 139.5 per cent respectively as compared to the untreated controls. Comparing the two strengths of Perenox, *i.e.* ¼th and ½ per cent used in the experiments, no appreciable difference in yield is observed. Dithane, when used alone or in combination with zinc sulphate + lime, or zinc sulphate + lime + D.D.T., has given only slight control of the disease as judged by yield data. Perelan dust has proved superior to Dithane sprays, but it is much less effective than the other copper fungicides, *viz.* Burgundy Mixture and Perenox.

Perenox and Perelan dust are copper compounds and are proprietary fungicides of Imperial Chemical Industries Ltd., while Dithane is an organic fungicide manufactured by Rohm & Hass Company, U.S.A.

Observations on the effect of different treatments on tuber size showed that comparatively larger sized tubers had been produced in the plots treated with Perelan dust, Burgundy Mixture, and Perenox in comparison to Dithane sprays and untreated controls. The untreated controls produced comparatively the smallest tubers in both the years.

At the time of harvest the percentage of tubers found infected with Late Blight was recorded under different treatments with a view to study the relative efficacy of the various fungicides against tuber-rot in the field due to the disease. On the whole, there was very low incidence of Late Blight infection on the tubers. A comparatively higher percentage of infected tubers were, however, obtained in untreated controls and in the plots treated with Dithane sprays and Perelan dust.

Assessment of Loss Due to the Disease:—The assessment of loss due to disease was carried out by taking visual observations on the percentage leaf area destroyed under different treatments on the basis of the Key formulated by the British Mycological Society (Anonymous, 1947) as well as on actual yield basis. Observations on the measurement of the disease were started soon after the infection was observed in the experimental plots and continued to be recorded regularly at an interval of 10-12 days till the crop completely matured. Thus the relative rates of spread of the disease under different treatments as well as the ultimate loss of leaf area due to the disease were studied. The observations recorded during 1948 and 1949 are summarized in tables 2 and 3 respectively:—

The data presented in tables 2 and 3 show that there is no fungicide which has been effective in keeping the foliage completely free from Late Blight infection. There is, however, appreciable difference in the ultimate loss of foliage in the plots treated with Perenox ½ per cent, Burgundy Mixture, and Burgundy Mixture + D.D.T. as compared with the untreated control. The three Dithane sprays and Perelan Dust have only retarded the progress of the disease for a short period, but ultimately the loss of foliage is almost equal to that in the untreated controls. Perenox when sprayed in ¼ per cent strength has proved to be less effective, as regards the ultimate loss due to Late Blight, than ½ per cent spray or Burgundy Mixture, but is superior to Dithane sprays and Perelan dust. The relative rates of spread of the disease on the basis of the percentage leaf area destroyed on different dates under each treatment during 1949 is shown in figure 2.

As regards the relationship between the amount of leaf area destroyed and the yield, there are two aspects involved: (1) the influence of varying rates of progress of the disease during its course upon the ultimate yield, and (2) yield in relation to the total ultimate loss of

TABLE 2.—*Average percentage loss of leaf area destroyed on different dates under different treatments during 1948*

Sl. No.	Treatment	Percentage Leaf Area Destroyed		
		30.8.48	10.9.48	22.9.48
1	Dithane	0.775	15	95
2	Dithane + zinc sulphate + lime	1	10	68.75
3	Dithane + zinc sulphate + lime + D.D.T.	1	15	73.75
4	Perenox ¼ per cent	0.325	3	31.25
5	Perenox ½ per cent	0.775	2	3
6	Burgundy Mixture	0.075	0.325	15
7	Burgundy Mixture + D.D.T.	0.05	0.1	5
8	Perelan Dust	1	5	67.5
9	Untreated Control	1	37.5	97.5

TABLE 3.—*Average percentage loss of leaf area destroyed on different dates under different treatments during 1949*

Sl. No.	Treatment	Percentage Leaf Area Destroyed					
		8.8.49	18.8.49	28.8.49	12.9.49	23.9.49	7.10.49
1	Dithane	0.05	31.25	50	73.75	97.5	100
2	Dithane + zinc sulphate + lime	0.075	8	10	56.25	72.5	95
3	Dithane + zinc sulphate + lime + D.D.T.	0.05	2	3	20	62.5	85
4	Perenox ¼ per cent	0.075	0.325	0.775	15	20	31.25
5	Perenox ½ per cent	0.06	0.1	0.1	0.7	5	11.6
6	Burgundy Mixture	0.05	0.1	0.325	1	3	5
7	Burgundy Mixture + D.D.T.	0.05	0.1	0.1	1	4	5
8	Perelan Dust	0.075	0.775	3	31.25	56.25	90
9	Untreated Control	0.05	37.5	62.5	96.25	100	100

During 1948 as the disease had appeared in the 3rd week of August and the crop completely matured by the last week of September, only 3 observations on the percentage of leaf area destroyed could be recorded during the season, whereas in 1949 the disease was first observed during the first week of August and the crop became ready for harvest toward the middle of October, a total of six observations was recorded.

foliage. A comparison of yield data, provided in table 1, with the corresponding figures of average percentage loss of leaf area destroyed by the disease on different dates during 1948 and 1949, presented in tables 2 and 3 respectively, show that the rate at which the disease progresses and the total period during which the foliage remains considerably green as a result of protection provided against the disease by the application of different fungicides greatly influence the ultimate yield. For instance, the ultimate loss of leaf area destroyed by the disease is almost equal in the plots sprayed with Dithane alone and the untreated controls, but the yield is higher in the former than in the latter, and this difference was much more marked during 1949 when the disease affected the crop for a longer period. This is obviously caused by the fact that the disease progressed far more rapidly in untreated controls than in the plots treated with Dithane, although the ultimate loss of foliage is almost equal in both. Figure 3 shows the relationship between the ultimate amount of leaf area destroyed by the disease and the yield under different treatments on the basis of the results obtained during 1949. It is evident that although there does not exist an absolute correlation between ultimate loss of leaf area caused by the disease and the yield, it is apparent that the yield increases with decrease in the loss of leaf area and *vice versa.*

For estimation of actual loss caused by the disease, according to Chester (1950) under such conditions, the truest measure of loss is expected to be the difference between the "best" treatments and the untreated control, and because even the "best" treatments frequently do not give 100 per cent control of the disease, only relative and not absolute loss can be measured. Therefore, taking into consideration the average yield of 43 pounds 0.3 ounces obtained in the plots treated with Burgundy Mixture which has given the best control in terms of yield as compared with the average yield of 17 pounds 15.35 ounces obtained in untreated controls, the loss due to Late Blight under the conditions prevailing in higher hills of Simla region is 58.2 per cent. However, the net gain in yield due to the beneficial effect of Burgundy Mixture, which has proved to be most efficacious, is 139.5 per cent over untreated controls.

Economic Aspect of Spraying:—The figures of average yield obtained under different treatments during the two years the experiments were conducted show that in the plots sprayed with ¼ per cent Perenox and Burgundy Mixture the yield is increased by 71.4 and 139.5 per cent respectively compared with the controls. The total cost of seven sprayings (100 gallons each) per acre, which is the maximum number of sprays to be applied throughout the crop season under the worst conditions of the disease, calculated on the basis of prevailing market rates at Simla (Perenox @ Rs. 154/6/— per 70 pounds, copper sulphate @ Rs.—/10/9

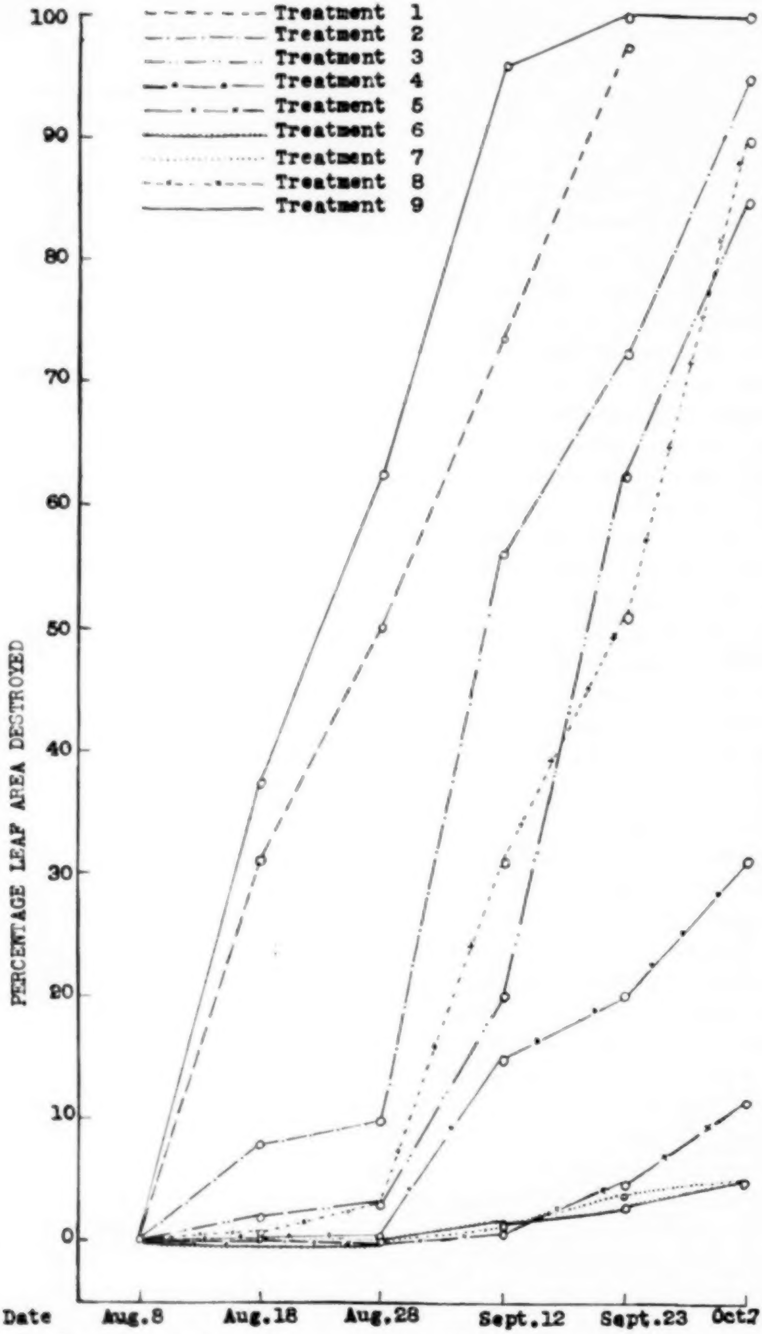

Fig. 2:—Percentage leaf area destroyed under different treatments during 1949.

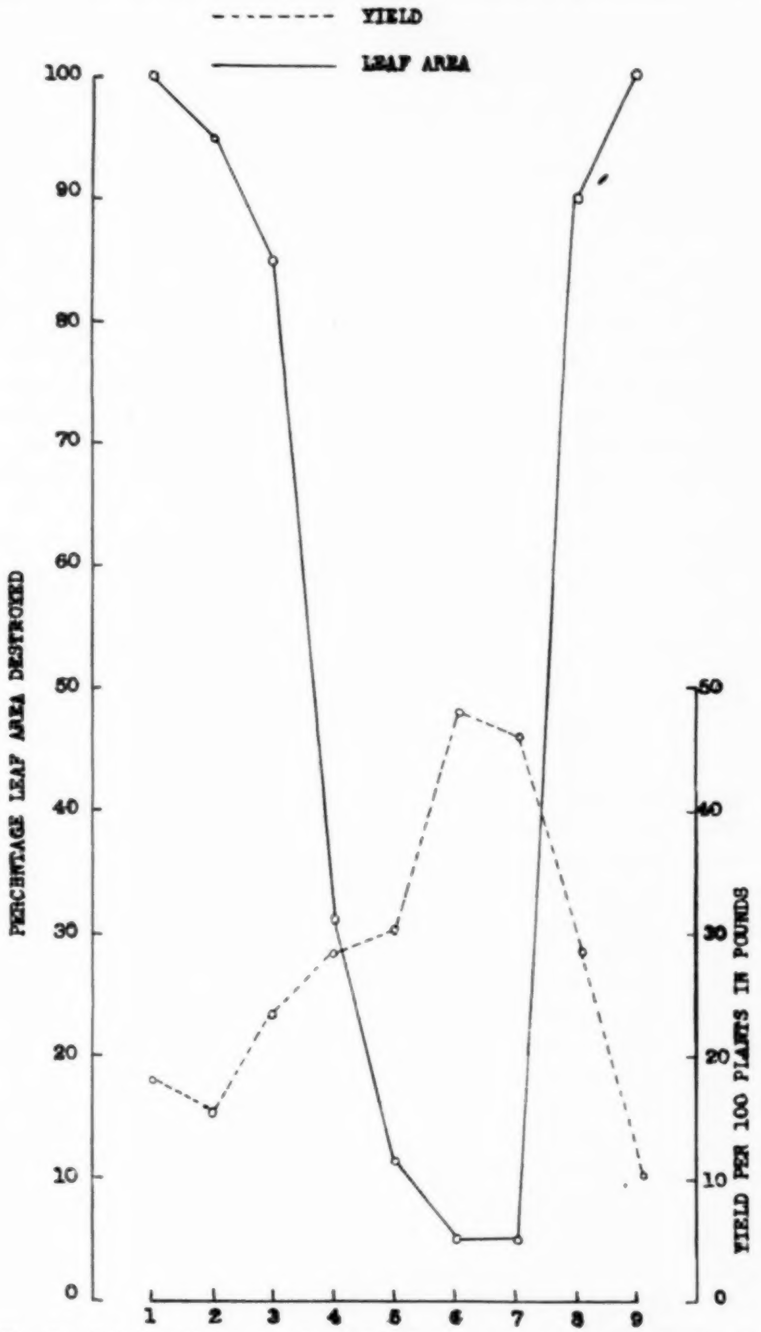

Fig. 3:—Relationship between loss of leaf area due to the disease and yield.

per pound and washing soda @ Rs.—/3/5 per pound) is Rs.38/9/6 per acre with ¼ per cent Perenox and Rs. 131/7/— per acre with Burgundy Mixture (10:12½:30). These figures of cost of spraying do not, however, include labor charges.

In addition to increased returns per acre, the rotting of tubers both in the field as well as in storage is prevented and the potatoes, being free from infection and blemishes caused by the disease, bring a higher price both for seed as well as table purposes.

Discussion

The data presented show that none of the fungicides tested can completely control the disease. Spraying with Burgundy Mixture and Perenox, however, considerably retards the progress of the disease both regarding its incidence as well as intensity of infection in affected plants, thereby reducing the ultimate loss. No appreciable difference in yield has been observed in the two treatments where ¼ and ½ per cent Perenox have been used. The effect of different treatments is more marked in the data presented for 1949, since the disease appeared in a more virulent form during that year. Under conditions of high rainfall prevailing in the higher hills of the Simla region, only that fungicide which can withstand frequent rains can be effective. It may be pointed out here that there were almost continuous rains during July-August, so much so that there was usually a drizzle or rain shortly or even immediately after the application of treatments. During the critical period for the disease the humidity was above 80 per cent and most of the time above 90 per cent. It is apparent therefore, that Dithane + zinc sulphate + lime which has been reported to effect appreciable control of the disease almost entirely failed under conditions prevailing at Kufri. Vaughn and Leach (1947) also found that Dithane + D.D.T. failed to control the blight when applied to a large commercial field and came to the conclusion that because of variations in climatic conditions, spray materials vary in their effectiveness in different localities and that under conditions of a heavy epiphytotic of Late Blight coinciding with a continued wet, rainy period, Dithane + D.D.T. is not so effective as Bordeaux + D.D.T. Dykstra (1948) also observes that one of the drawbacks of this new fungicide (Dithane + zinc sulphate + lime) is that it is fairly unstable, and the results obtained in different sections of the country (U.S.A.) are not always consistent, and that in some of the Northern States Dithane was not effective in controlling Late Blight. During the course of the present experiments at Kufri it was further observed that Dithane remained effective only for a few days after application, after which it appeared to have lost its effect and failed

to check the progress of the disease. Ruehle (1947) also found that spray of Dithane + zinc sulphate + lime remains effective only from 7 to 8 days on potato foliage. He has further reported that in Florida where Dithane + zinc sulphate + lime has proved to be most effective against Late Blight, rains are infrequent during the season of the potato crop.
*4.72 Rs= 1S

Summary

Burgundy Mixture and Perenox have been shown to be most effective in the control of Late Blight of potatoes and the increase in out-turn effected by these was 139.5 and 71.4 per cent. respectively. Dithane almost completely failed to effect any appreciable control of the disease under conditions prevailing in the higher hills of Simla region.

No absolute correlation between the ultimate loss of leaf area destroyed by the disease and out-turn have been observed. A general indication has, however, been obtained that the yield decreases with increase in the loss of leaf area and *vice versa*. It has further been shown that the rate at which the disease progresses and the total period during which the foliage remains green as a result of protection provided by the fungicides against the disease, greatly influence the yield.

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Thanks are due to Dr. S. Ramanujam for providing facilities at Kufri for the period June to October 1949 when the station was transferred to the Central Potato Research Institute.

WILLIAM H. MARTIN HONORED BY THE POTATO ASSOCIATION OF AMERICA

Dr. William Hope Martin, dean of the College of Agriculture and director of the Agricultural Experiment Station and Extension Service, Rutgers University, was born June 3, 1890, in Carlisle, Pennsylvania.

He received his bachelor of arts degree from the University of Maine in 1915. Rutgers University awarded him his master of arts degree in 1917 and his doctor of philosophy degree in 1918.

From 1915 to 1918 Dr. Martin was research assistant in plant pathology at New Jersey Agricultural Experiment Station. He was associate plant pathologist there from 1919 to 1923 and pathologist since 1923. In 1926, he was named professor of plant pathology. He has been dean of the College of Agriculture and director of the experiment station since 1939. In 1945, he was appointed director of the Extension Service.

During World War I, Dr. Martin served as a second lieutenant in the Army Air Forces.

Dr. Martin first became interested in potatoes when assigned to work on blight and scab control work about 1918. He was soon assigned to work on all types of potato research including fertilizer analysis and placement research — devoted much time to control of scab by use of sulfur, and discovered a close relationship between scab development and soil moisture.

He became secretary of the New Jersey State Potato Association soon after its organization in 1919 and served in that capacity until 1948.

Dr. Martin was elected president of the Potato Association of America in 1923 and Secretary-Treasurer, and Editor of the American Potato Journal in 1933, a post which he held until 1948 when he relinquished the Secretary-Treasurer post to two successors but continued to act as Editor of the Journal to date.

Dr. Martin has guided the Potato Association through many difficult situations and has made the American Potato Journal a high class scientific Journal which is recognized as the scientific spokesman on white potato research throughout the world.

In addition to his first love; potatoes, Dr. Martin is a recognized leader in many other agricultural fields.

In 1935 Dr. Martin was named director of research at the experiment station after serving a year as acting director during a leave of absence of the late Jacob Goodale Lipman, whom he succeeded in 1939.

When the War Production Board in June, 1942, was confronted with a shortage of nitrogen, Dr. Martin was named consultant on chemicals to advise on farm fertilizers. He served part time in Washington and continued direction of the experiment station. In this position he was

able to effect substantial savings to industry and farmers through reducing the multiplicity of grades of fertilizer being produced.

During World War II, Dr. Martin's services were enlisted by the Federal Security Agency in conducting secret wartime research.

During 1948 he devoted much time to the Committee on Agriculture of the Commission on Reorganization of the Executive Branch of the Government, (the "Hoover Commission") which studied the possibilities of streamlining the United States Department of Agriculture.

Other organizations in which he holds membership include: American Association for the Advancement of Science, American Phytopathological Society, Sigma Chi, Alpha Zeta and Sigma Xi fraternities.

For relaxation, Dr. Martin fishes, and vacations usually find him angling in Maine. His fondness for the sport was recognized by the New Jersey Potato Association in 1945, when members gave him a canoe with an electric outboard motor, along with other gifts, in appreciation of the 25 years he served the association as corresponding secretary. Dr. Martin promptly named the canoe "Spud."

The Potato Association of America has been fortunate to have such an outstanding leader as the Editor of its Journal and it is with great pleasure that we bestow on him at this Annual Meeting an Honorary Life Membership in the Potato Association of America. (*J. C. Campbell*)

JOHN TUCKER HONORED

Born in England in 1883, John Tucker entered the Royal Navy in 1897 and travelled extensively. He was in the China, Korea and Japan area from 1902-1905 during the period of the Russo-Japanese war.

Leaving the sea, he went into partnership with a brother in Ontario, Canada, in a vegetable crops and early potato production project in 1906, which continued until the outbreak of the first World War in August, 1914, when he joined the Canadian Naval Service and served at sea again, until 1918.

The Dominion Botanist, Dr. H. T. Gussow, secured John Tucker's release from sea duties and, after a period of specialized training under the late Dr. Paul A. Murphy, the virus disease specialist at that time, he introduced seed potato certification work into Manitoba in the spring of 1919 and later that year into Saskatchewan under the direction of the late Dr. W. P. Frazer, Plant Pathologist.

In 1920, he qualified as District Inspector in charge of seed potato certification work in Ontario (where the work had been under way since 1918) and continued in that capacity with headquarters at the Agricultural College, Guelph, until appointed Chief Inspector of the Dominion Certification Services at Ottawa in 1927. He continued in the latter service

until his retirement in 1946. For the last two years of his service he was on loan to the Special Products Board as Manager of the Potato Section to regulate the sales and marketing for export of certified seed potatoes.

During his twenty-seven years with the Dominion Certification service John Tucker travelled from coast to coast in Canada many times, and attended most of the principal potato field days as guest speaker. He was also a frequent visitor to the United States, and has spent much time in the potato fields of many other lands. For many years he was a regular attendant at the annual potato field days in Virginia, Maryland and New Jersey. In the late nineteen thirties he spent several months visiting all the principal potato growing areas throughout the United States from Maine to California. He was in Cuba on two occasions at the invitation of the Cuban Government and he visited, on special assignment, the countries of Colombia, Ecuador, Peru, Chili, Argentina, Uruguay, Brazil, Costa Rica and Mexico.

John Tucker was a member of the Potato Association of America from 1920 to 1946. In the early thirties he was a member of the Executive for several years and was President of the Association for the years 1934 and 1935. He subscribed to the Journal from its inception, and contributed many articles for publication throughout the years. He was also a member of the Canadian Phytopathological Society from its inception.

Other interests in potato improvement work included potato judging at fairs and Boys and Girls Club work. He has judged all the potato entries at the Royal Agricultural Winter Fair, Toronto, Canada, from its start in 1923 until 1946, and has judged practically every other large potato exhibition throughout Canada at one time or another, and at some in the United States of America including the well-known "Top-O-Michigan" potato shows. In the Boys and Girls Club Work, he prepared the contests for the potato section at the National Competitions from the beginning of that organization, and until recently judged the competitions and the Club entries at the annual final shows. He was recently honored for this work by being voted Honorary Member of the Canadian Council on Boys and Girls Club Work.

Declining health in 1945 made it advisable to reduce his activities, but quiet country living at his old home in the Province of Ontario fortunately has resulted in some improvement and he intends to continue the treatment for a while longer. John Tucker says he feels greatly honored to be chosen as the recipient of an Honorary Life Membership in the Association and remembers with gratitude the personal contacts he made with so many members and their unfailing kindnesses towards him on every occasion in his long association with them.

—*N. M. Parks*

IN MEMORIAM

BAILEY EDGAR BROWN

November 10, 1879 — March 9, 1951

Bailey Edgar Brown was born in Cookeville, Tennessee, and, in 1899, at the age of 20, received his B.S. degree from Alabama Polytechnic Institute. The same year he was appointed assistant in bacteriology at Alabama Agricultural College and in 1900 received his M.S. degree.

Mr. Brown entered the United States Department of Agriculture in 1901 as a scientific aid in the Bureau of Soils. He participated actively in the early work of the Bureau under the leadership of Professor Milton Whitney, and in 1907 was assigned to Pennsylvania State College where for four years he conducted special cooperative studies on soil fertility problems. After his return to Washington, he was transferred to the Bureau of Plant Industry as biochemist in the Division of Soil Fertility Investigations under Dr. Oswald Schreiner, where he served in this Division for more than 25 years. Later he was transferred to the section of the Bureau concerned with Potato Investigations at the Plant Industry Station, Beltsville, Maryland. He retired from the Department July 26, 1946, as senior biochemist after 45 years of service. After retirement he acted as agricultural advisor to the Summers Fertilizer Company of Baltimore, Maryland, for approximately 2 years.

Mr. Brown's long career in soil fertility work resulted in numerous government publications and many articles in scientific journals, the total numbering more than 125. His most outstanding contributions dealt with the nutritional and cultural practices of potato production. It was largely through his efforts that the band placement method of fertilizer application for potatoes was thoroughly tested and the value of concentrated fertilizers demonstrated. His ability to see the farmer's viewpoint and to seek solutions to technical problems directly on the farms was outstanding. His experimental work throughout the years in cooperation with potato growers, experiment stations, and county agents stands as an excellent example of highly successful cooperative effort leading to valuable scientific and practical results.

Dr. Brown was a long-time member of the Potato Association of America and the American Society of Agronomy. He is survived by his widow, Mrs. Mary E. Brown of 1207 Delafield Place, NW, Washington, D. C., and one daughter, Elizabeth, of the same address.

G. V. C. Houghland

HENRY R. TALMAGE 1871—1951

Henry R. Talmage, for over half a century an outstanding figure in Long Island agriculture, died on Sunday evening, January 28, 1951, at his home in Baiting Hollow. His death occurred a month after his 79th birthday.

Best known as a farmer, a leader in farm organizations, and the head of a major produce and supply company, Mr. Talmage's seemingly limitless energy found expression in many other fields. He died on the eve of the fruition of a great community project of which he was the chief author. As a founder and president of Central Suffolk Hospital, he was to a large degree responsible for the building of the new $825,000. hospital in Riverhead, which opened the week following his death.

Descended from an old Long Island family, Mr. Talmage was born in Westhampton on Dec. 28, 1871, the son of Nathaniel Miller Talmage and Mary F. Raynor Talmage. Ten years later, his father, a civil war veteran, moved his family across the Island to a farm in Baiting Hollow. There the son began his long and successful career as a farmer, and in the years following his succession to the ownership the original parcel of some 100 acres was expanded to the Friar's Head Farms of today with its more than 200 acres of highly productive land.

In a day when "book farming" was a term of disparagement, Henry Talmage prepared for his chosen profession by taking the short courses at the State College of Agriculture at Cornell. There his formal education ended, but his thirst for knowledge was never satiated throughout his long lifetime.

He studied marketing with the result that in 1901 he and several fellow growers organized the Long Island Cauliflower Association, which now, in its fiftieth anniversary year, is among the largest and most successful marketing agencies in the United States. For nearly 35 years Mr. Talmage served the association as either president or vice-president and he was director for an even longer period.

A quest for disease-free seed potatoes led indirectly to the formation in 1922 of the Long Island Produce and Fertilizer Co., Inc. Mr. Talmage and his good friend and neighbor, the late Chauncey H. Young, were the co-founders. He succeeded Mr. Young as president of the company and served in that capacity until his death.

Mr. Talmage's many contributions to agricultural progress were given recognition in 1929 when he was designated a master farmer of New York State. About the same time, he was appointed to the State Agricultural Advisory Committee by the then Governor, Franklin D. Roosevelt. For 10 years, on Mr. Roosevelt's nomination, he served on the State Banking Board as spokesman for the farming interests of the Empire State.

He was founder of the Suffolk County Farm Bureau and served on its executive committee. He was instrumental in the formation of both the State Farm Bureau Federation and the American Farm Bureau Federation, and was for 12 years a director of the state agency. He served as a director of both the National Plant Breeding Association and the Northeast Potato and Vegetable Council, and was an organizer of the more recently established National Potato Council.

Nearly 30 years ago Mr. Talmage and several other growers put up the money for a Cornell fellowship, under which a graduate student investigated the disease and insect problems of the cauliflower industry. This led to the establishment of the Long Island Vegetable Research Farm at Baiting Hollow, as a branch of the Cornell Experiment Station. Mr. Talmage spearheaded the drive for the original legislative appropriation and has since cooperated in expanding the farm plant and the station's services to farmers.

In addition to his numerous organizational activities, Mr. Talmage pioneered many agricultural advances. He had a leading role in the mechanization of Long Island's farm plant in the 1920's and 1930's. His Baiting Hollow farm has long been a proving ground for new crops, new methods, and new machinery. With it all, he has kept exact and elaborate records covering all phases of the operations of Friar's Head Farms, and he was considered the final authority on local crop costs and returns. In late years his work in introducing and popularizing portable overhead irrigation on Long Island has had a profound effect on the agriculture of the region, where today over 80 per cent of the farms are irrigated.

Mr. Talmage was an organizer and director of the Riverhead Hotel Association, which owns and operates the Hotel Henry Perkins. He was a member of the Baiting Hollow Congregational Church, the Riverhead Rotary Club, the Sound Avenue Grange, and the Riverhead Masonic Lodge.

It has been said of Mr. Talmage that it was pure torment to him to see a job and be compelled to leave it undone. This was as true in civic or community work as it was on his own farm. In him were combined the gift of vision together with a hard core of practicability and common sense and a rare ability to get things done. For all his attainments and the very considerable prestige that accomplishment brought him, he remained a modest and unassuming man, a good friend, and a considerate and helpful neighbor.

Mr. Talmage is survived by his wife, Mrs. Ellen Wells Talmage; a son, Nathaniel A. Talmage; who has been a partner in farming enterprises; a daughter, Mrs. Christine Bayes of Breckenridge, Michigan, and a sister, Mrs. Caroline B. Hulse of Riverhead.

George Cushman

RESEARCH IN POTATOES

Ingolfur Davidsson. (Reprinted from Research in Agriculture.)

1. During the years 1937-1950 an investigation was made to find out which plant diseases affect the main crop plants in Iceland both in the field and in green-houses. Various measures of control of the diseases have been tried. At the same time the spread of the various plant diseases was investigated and the losses caused by them estimated.

2. The investigation has shown:—

   (e) that most plant diseases on out-of-door plants have existed in the country for a long time, *e.g.* Late Blight, Blackleg and Common Scab of the potato.

3. Investigation of the most important plant diseases.

   (a) *Diseases of the Potato:* —Late Blight is known in all parts of the country, but does not cause serious losses except in the Southern part where it is met with every year, although it causes much greater losses in some years than others. Since 1918 Late Blight has casued serious losses in 11 seasons. It usually appears so late in the season that the foliage does not suffer until the beginning of September. Therefore it does not cause a great decrease in the total yield, but reduces considerably the value of the crop owing to damages during storage. Two sprays with Bordeaux mixture or Perenox have been found to diminish the damages from 20-40 per cent to 2-5 per cent in bad blight years. The most susceptible are the "indigenous" Icelandic varieties (the Red Potato, the Blue and the Akranes), the "Gulloga" (an old Swedish variety) and Early Rose. The early varieties Arran Pilot, Arctic Seedling and Webb's Early are also affected considerably. Less susceptible are Ben Lomond, Great Scot, Up-to-date and Eigenheimer. The most resistant varieties are Alpha and Ackersegen.

   Blackleg (Bacillus phytophthorus) is known in all parts of the country, but is most prevalent in the South-West, where most of the imported "seed" potatoes are used. Kerr's Pink is the most susceptible variety and this has greatly reduced the popularity of this variety. All other varieties, wihch have been tested, have been found to be somewhat susceptible, except the Red Icelandic Potato. The disease appears usually so late in the season that it is difficult to sort out the affected plants. Usually 2-4 per cent of the crop is affected with Blackleg.

   Mosaic (virus) is often carried with foreign "seed" potatoes, but does not spread much due to the fact that aphids are rare on potato foliage.